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ABSTRACT

This booklet consists of two papers delivered by Patrick Haggerty, chairman of Texas Instruments, Incorporated, on the general topic of productivity in the American educational system. The first paper, "Education, Work, and Productivity," points out that while productivity per man-hour in the private sector of our economy has been increasing, productivity per man-hour in the educational sector has decreased markedly as educators continue to push for lower student/teacher ratios. The author suggests that this trend can be reversed by utilizing such technological advances as video cassettes and instructional television networks to extend education beyond the classroom and improve educational results while increasing student/teacher ratios. The second paper, "R & D and Productivity in Education," suggests that improved educational productivity can best be achieved by changing from our present teacher-oriented educational system to a student-oriented system. To achieve this shift will require an expansion of research and development efforts focusing on student-centered education, the author argues. (JG)

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Two addresses by
Patrick E. Haggerty

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Productivity In Education

FOREWORD

Education is our most pervasive occupational commitment in the United States. In 1972, for example, we had more than five million adults in instruction and administration and more than 60 million students, so that over 31% of our total population had made education its principal time commitment.

As a nation, we spent almost $86 billion in support of academic educational institutions in the school year 1971–72, or about 8% of our Gross National Product. The sheer scale of commitment of resources alone is sufficient to justify concern about how we may improve productivity in education. And yet, there is every indication that both the needs and the interests of the American people suggest we need to enlarge our educational efforts.

If we hope to meet, in any meaningful way, these enlarged opportunities, we must succeed in improving productivity in education so that the resources released may be devoted to these enlarged needs and opportunities.

Both the need to improve productivity and the methods to accomplish this improvement have been general interests of mine for many years, and improving productivity in education has held special interest because of the very large opportunity it presents.

The two papers making up *Productivity in Education* were presented in 1972 and 1974, respectively. Although there is a limited amount of redundancy, they are sufficiently complementary to be much more informative when read together than either is separately.

Patrick E. Haggerty

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EDUCATION, WORK, AND PRODUCTIVITY

Address by Patrick E. Haggerty
Chairman, Texas Instruments Incorporated

for the
Dallas Independent School District
February 24, 1972

Some months ago at a dinner meeting it was my privilege to sit beside the wife of an eminent retired university president. This lady and her husband, still possessed of great mental and physical energy, are themselves operating very successfully a good-sized farm in the southeastern United States. During the course of the evening's discussion, this distinguished lady drew upon her experiences with young people on the farm to argue very convincingly that these young men and women, growing up, doing useful work, and learning as they worked on their own and neighboring farms, neither caused nor faced most of the problems associated with youth growing up in the city. From these experiences she argued that it was futile to seek solutions through our city schools and that the right approach lay in taking the young people out of the cities and putting them on the farms to work, to grow, and to learn. She was startled when I pointed out then, even if she were right in her premise, following her recommendation could have no significant impact on youth growing up in the United States today. The reason, of course, is very simple. There just aren't very many people left on the farm, and there are going to be even fewer in another decade.

Most of us who grew up in, or still have connections with, rural America know there is much wisdom in my friend's observations. Unfortunately, the United States has changed so overwhelmingly to an urban society that only urban solutions can meet our needs.

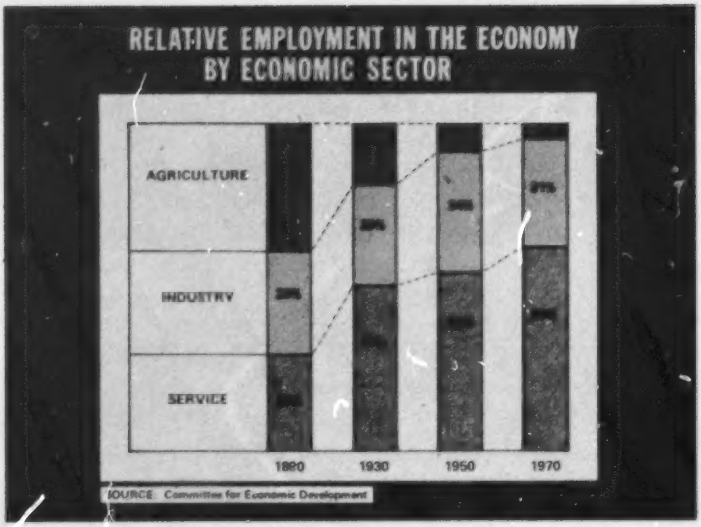

Figure 1[1]

There probably is no clearer way to trace the development of the United States from an agricultural to an industrial society and the continuing shift to what some are now terming a "post-industrial society" than to examine the changes in how our people are employed (Figure 1).

As recently as 1890, four out of every 10 workers were engaged in agriculture, forestry, or fisheries. By 1930 that percentage had been halved, and in 1970 only 4% of our workers produced relatively even more food and forest products.

We had 28% of our workers in industry in 1890, and that percentage grew slowly, reaching 34% in 1950. Since then, however, in spite of the increasing quantity and variety of industrial goods we produce, the percentage of our total workers in industry declined to 31% in 1970.

The really striking shift is in the category known as "service," which includes transportation, communications,

utilities, wholesale and retail trade, government, and education, in addition to other services. In 1890 only 29% of our workers were engaged in service areas. By 1950 this percentage had nearly doubled, and in 1970 nearly two out of three of our workers were so engaged.

The implications of these shifts are profound. They have come about because the ever-increasing productivity per person, especially in agriculture and industry, has allowed us to turn our efforts to providing services, particularly education and government.

Productivity per person engaged in agriculture no doubt will go on increasing at 4% to 6% per year, and in a few decades perhaps 2% of our working population will produce all of the agricultural products we need. However, even though agriculture goes on increasing in productivity per person, it can no longer have a very large impact on improving the standard of living of our society or, to look at it another way, to free workers now engaged in producing food for work in government, education, or health care.

Increasing productivity per person in industry, too, will mean we require relatively fewer workers to produce the ever-increasing quantity of material goods we use to live. It is highly probable that by the year 2000 we will need only 25% of our total workers in agriculture and industry to produce all of the food and goods we need, and three out of four of all who work will be in services. Thus, whatever the social and educational values of growing up on the farm, no matter how diligently we try, we are not likely to expose very many of our young people to those advantages. Equally clearly, the great preponderance of young people you help educate will be working in those same service areas rather than on farms or in factories.

Increasing productivity per person, of course, is just another way of saying that output per hour worked per man has gone up remarkably. Indeed, in the private sector of our economy, our society now produces about six times

as much in each hour worked as it did in 1890, and it is from this increase in output per man-hour that we have attained our real improvement in standard of living. This ability to improve our output per man-hour consistently is probably the most significant material accomplishment of contemporary industrial society.

What has made it possible? Among the principal factors are:

1. How we organize for work; i.e., how we manage;
2. Use of science and technology in multiplying the effectiveness with which we work;
3. Use of capital, as reflected in machines, tools, plants, and supplies to multiply effectiveness of each individual working;
4. Economies of scale; i.e., as our country grew and as we developed markets, we found ways to apply our total efforts more effectively. Larger markets made bigger tools and better technology possible;
5. The consistently improving educational level of the total work force, which contributed to the increasing productivity per person;
6. Most important of all, the nature of the system itself, within which all of these factors can operate to improve effectiveness. Our private enterprise system is a profit-or-loss system, and every manager within it knows that the total funds he receives for the products and services his organization turns out must exceed his total costs by an amount which is adequate to pay for the investment of the shareholders and to provide internal growth. Consequently, if wages and salaries go up, either prices must go up or costs must come down, and the competition within the system inevitably puts a lid on prices.

As a consequence, the private industrial sector is especially well organized to improve its productivity constantly. At Texas Instruments, for example, we know very well that if wages and salaries go up 5%, either our prices

must go up or our costs must go down accordingly. Since competition limits our prices, we spend a very large proportion of our total professional effort in improving our effectiveness—in management systems, in new products, in new processes for manufacture, in marketing, in more effective tools and machines and layouts, and in training people. In product lines that encompass about half our total volume we have faced price cuts approximating 15% per year for more than a decade; yet, with wages and salaries increasing at a rate of 3% to 5% per year, we have managed not only to survive but to grow and to profit.

Profits before taxes at Texas Instruments are running around 8%. Of that amount a little less than half is paid out in the form of income taxes. About one-quarter of the 4%-plus that remains goes to our shareowners in the form of dividends, and they in turn pay from one-quarter to one-half or more out to governments in the form of income taxes. The percentage that remains (presently 3%, but sometimes more, sometimes less, and it really needs to be 4% or better) is what has produced most of the necessary funds that have allowed us to grow to 400 times the size we were in 1946. Thus, it would have taken only a relatively small decrease in our effectiveness through the years to put us in a loss instead of a profit position. This would have stopped our growth immediately and, if continued over a few years, would have been cured either through a change in management or through the death of the organization. Thus, we have no alternative to improving our productivity. It is built into our culture.

But this ability to improve productivity per person at a high rate is not automatic, and it is not universal throughout all the endeavors of our society. There is good reason to feel, for example, that productivity per person employed in education actually has decreased over the past decade or two.

Since 1930, our population has grown from 123 million to 205 million, about 60%. During that same span of time,

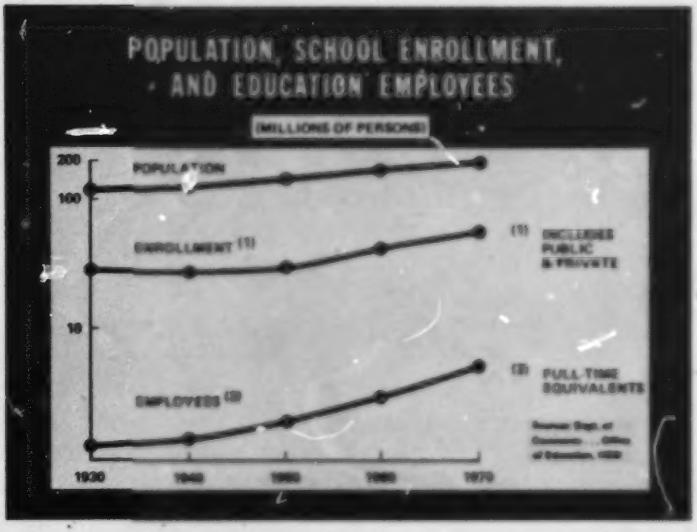

Figure 2

our school enrollment doubled, from 29.7 million to 59.1 million, but the number of full-time equivalent men and women employed in education grew more than four times, from 1.3 million in 1930 to 5.4 million in 1970. Thus, in the last 40 years, the number of full-time employees in education has grown twice as fast as the number of students and more than three times as fast as the population (Figure 2).

Expressed in 1970 dollars, between 1930 and 1970 our total expenditures for education for all levels have grown more than nine times, from $7.5 billion to $70.3 billion. Remember, these are in constant 1970 dollars (Figure 3).

Or what is much more meaningful, again in constant 1970 dollars, our expenditures per student have grown nearly five times, from $253 per student in 1930 to $1,188 per student in 1970, and the biggest increases have come since 1950. We now spend nearly three times as much per student in constant 1970 dollars as we did in 1950.

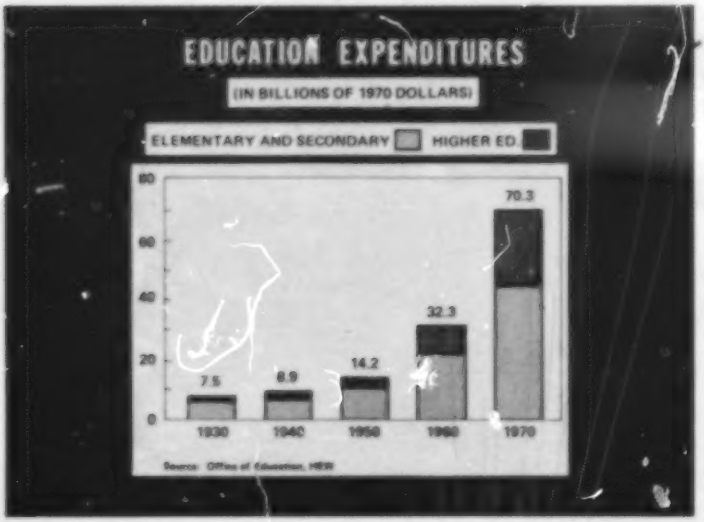

Figure 3

However, these comparisons are not completely fair because the number of students in higher education, where the costs per student are obviously much higher, has increased more rapidly than in elementary and secondary schools. Still, as Figure 4 shows, since 1950, costs for elementary and secondary education grew from $377 to $885 per student, or more than 2-1/3 times, and the costs of higher education increased somewhat more rapidly, from $1,259 per student to $3,152, or 2-1/2 times.

As to the nature of the forces generating these disparities, let me quote from "The Economics of the Major Private Universities," a paper by Dr. William G. Bowen, Provost of Princeton University and Professor of Economics and Public Affairs, which was published by the Carnegie Commission on Higher Education:

> "Let us imagine an economy divided into two sectors, one in which productivity is rising and another in which it is constant, the first producing automobiles, and the second, 'education' (defined as some

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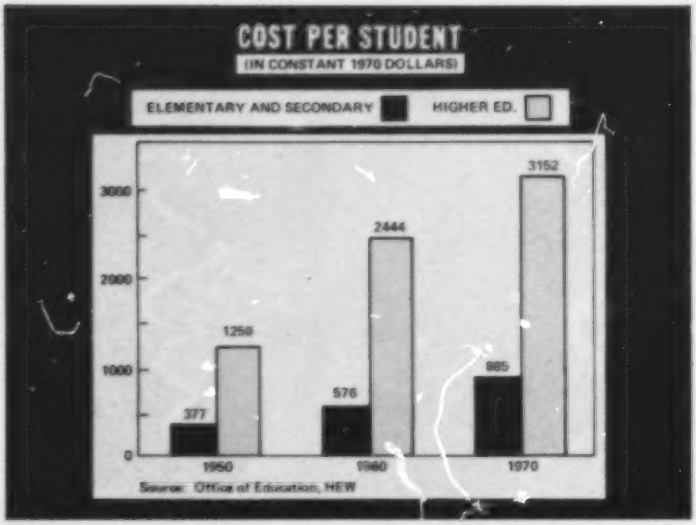

Figure 4

amalgam of students and knowledge). Let us suppose that in automobile production output per man-hour increases at an annual rate of 4 percent, compared with a zero rate of increase in the education industry. Now let us assume that money wages in the automobile industry go up at the same rate as productivity in that industry. This means that each year the typical auto worker's wage goes up by 4 percent, but since his output increases by exactly the same percentage, the labor cost of manufacturing a car will be unchanged. This process can continue indefinitely, with auto workers earning more and more each year, with costs per car remaining stationary, and with no rise in automobile prices necessary to maintain company profits.

"But what about the education industry? How it fares in this imaginary economy depends on what assumption is made about the relationship between increases in faculty salaries (treated, for the sake of

simplicity, as an index of all salaries in the education industry) and the increases in the wages of auto workers. Over the long run, it is probably most reasonable to assume that faculty salaries increase at approximately the same rate as wages in other sectors. (Between 1948 and 1966, professorial salaries have increased slightly faster than earnings of production workers in manufacturing—4.8 percent per year for the former and 4.2 percent for the latter. However, if we take either 1929 or 1939 as our base year, we find that faculty salaries have increased somewhat less rapidly than earnings in manufacturing. It was during the World War II period that the relative income position of faculty members deteriorated so markedly.)

"If the salary of the typical faculty member does increase at an annual rate of 4 percent, so that his living standard improves along with the living standard of the auto worker, but if output per man-hour in the education industry remains constant, it follows that the labor cost per unit of educational output must also rise 4 percent per year. *And there is nothing in the nature of the situation to prevent educational cost per unit of product from rising indefinitely at a compound rate of this sort.*

"The particular assumptions included in this analysis are, of course, merely illustrative, and the numerical results can be changed by assuming a different rate of productivity increase and a different rate of increase of money wages in the non-educational sector, by assuming that faculty salaries increase at a somewhat different rate from money wages in general (either faster or slower), and by allowing for some increase in productivity in the field of education. But modifications of this kind will not alter the fundamental point of the argument, which is that *in every industry in which increases in productivity come more slowly than*

in the economy as a whole, cost per unit of product must be expected to increase relative to costs in general. Any product of this kind—whether it be a haircut, a custom-prepared meal, a performance of a symphony concert, or the education of a graduate student—is bound to become ever more expensive relative to other things."[2]

The pressures Dr. Bowen outlines would apply if the ratio of students per employee in the education industry were constant. Since in fact the ratio has been decreasing, and we have been using more employees in the education industry to produce the same number of students, a double compounding has been taking place.

Do any of you honestly believe that today's students are, on the average, two to three times better prepared than they were just 20 years ago? In fact, do you believe that, on the average, they are as well prepared, considering the difficulties and the instabilities of the times? Thus, whatever the causes, one is forced to conclude that there has been a marked decrease in productivity per person engaged in education.

Here is a statement much closer to home from an address made last March by Dr. Nolan Estes before the Educational Testing Service in Washington, D.C., in which he emphasized the need for accountability in education:

"For five years—ever since the passage of the Elementary and Secondary Education Act gave us the extra financial boost we needed to develop compensatory programs—we had been trying all the old tricks and most of the new to improve achievement among those children whom we call the 'culturally disadvantaged.' Along with other school districts all over the country, we bought shiny new hardware and clever new software; invested in workshops and seminars for our teachers; sent our kids to concerts and museums and factories and even—courtesy of Braniff International—up over the city in planes. In

sum, we waved the banner of innovation as energetically as anyone.

"Naturally, even though we got a considerable boost from Title I and other forms of federal aid, our costs went up. They tripled in the last 10 years—mainly because of new construction, salary increases, and improvements such as air-conditioning; but partially because we asked the citizens of Dallas to stretch federal dollars with their own. And when we totaled the results of this financial exertion on the part of the taxpayers, and of the spiritual exertion on the part of our teachers, we found we didn't have much to be proud of.

"Our target had been those schools in which students were averaging only a half-year's achievement gain for every full scholastic year. By the time we finished, we had not managed to improve on this sad record; in fact, some of our Title I schools were worse off in 1970 than they had been in 1965.

"Any sane school superintendent is reluctant to hang out his dirty linen for public viewing. I cannot suppress a certain sense of embarrassment even now, as I speak. All that gives me courage to do so is the knowledge that virtually every other large city school system in the country has had the same experience as Dallas. Five years and five billion dollars after Title I was passed, we still have not learned how to break the cycle of underachievement that sees children from poor homes do poorly in school; find poor jobs or none; marry—and then send their own poor children to school.

"But though this failure remains constant, some things *have* changed in education—notably the public attitude toward those who run it. Ten years ago, we educators confidently asserted that we knew how to cure educational illness. All we needed was enough money to lower pupil-teacher ratios, put a library in

every school, an overhead projector in every classroom, and so on and so forth. Our prescriptions for educational excellence were based on traditional notions that went unchallenged because a stingy public had never allowed us to try them.

"During the 1960's, we got a chance to try them; not as much of a chance as we would have liked, perhaps—too many school systems spread Title I funds around so thinly that the extra money could not have any impact. Nevertheless, we were given a reasonable chance—and the results did not justify the investment. And today, it is clear, the public does not believe it is getting its money's worth from public education."[3]

Indeed, there are a great many signs that reflect the extent of the dissatisfaction of the taxpayer with public education. Here are some of the consequences reported in a *Wall Street Journal* story in 1971:

- Teachers are being laid off for first time since the Depression.
- New York Board of Education will reduce its teaching and administrative force by 6500 to head off $40-million budget deficit.
- The California Teachers Association says that fully half of 1000 school districts in the state have notified teachers of possible layoffs in September.
- In Ohio, only 29% of (school bond) issues were okayed at the polls last year (1970).
- In Cincinnati, kindergarten pupils next fall will get only 10 weeks of instruction instead of present 20, and all elementary school libraries are to be closed.
- Layoffs have also been announced in the affluent communities of Wilmette, Arlington Heights, and Niles Township.
- The number of teacher college graduates is almost triple the number of new job openings being created by resignations and retirement.[4]

That dissatisfaction has been spelled out even more clearly in taxpayer reactions to bond issue renewals and approvals which have been the mainstay for financing the capital needs of schools (Figure 5).

Note that where only one out of four bond issues was rejected in 1965, in 1970 the number had climbed until it was almost one out of two.

As Dr. Estes stated, it has been pretty much doctrine that all that was necessary to solve the problems of the education industry was sufficient money. It would seem to me that the events of the past 20 years should have dispelled that illusion completely. After all, spending approaching three times as much per student (in constant dollars) does not seem to have improved the effectiveness of the system or the quality of the end product appreciably.

More money will help, but not much, if the record of the past 20 years means anything! Remember Dr. Bowen's observations. If the productivity in the rest of the economy

Figure 5

SCHOOL BOND ISSUES, 1965-1970 SUBMITTED AND REJECTED

	1965	1966	1967	1968	1969	1970
TOTAL SUBMITTED	2041	1745	1625	1750	1341	1216
TOTAL REJECTED	516	480	543	567	579	569
PERCENT REJECTED	25	28	33	32	43	47

Source: Congressional Record, Jan. 18, 1972, p.E1

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is increasing and that in education is not, then it will take a considerable amount of money per year merely to keep the pay scales of those in the education industry comparable to those in the rest of society, even though nothing more is being produced for the additional funds.

Thus, however unpalatable the realization may be to those in education, the employees of the education industry have been completely dependent for any real gains in their own incomes these past decades upon the increasing productivity of the other sectors of the economy. Further, unless those engaged in education can increase the productivity per person annually at a reasonable rate, they are going to go on being dependent for any increases in their own real income on the gains made by the work of others in those sectors of our economy where the productivity is increasing.

There are four vital points that must be made:

1. Any questions raised with respect to decreasing productivity per person within education itself are not about the advantages of education for all but only about the institutions and the procedures—with how and what and when we have chosen to provide the education. Education for all to the maximum of capability and desire is a proper objective in that higher standard of living (expressed in the broadest terms) we seek for the United States.
2. As I mentioned earlier, a portion of the increasing productivity per person in the private sector is attributed to the constantly increasing educational level of our total population. Thus, to the extent that the additional costs go to training a larger percentage of the population to a higher level of education, the education industry is entitled to a share in the productivity gains made by the private sector.
3. The problems within the educational system which have produced the constantly decreasing productivity are at least as much the fault of society itself as they are of the educational industry. After all, we outsiders

make up most of the population, and we elect the school boards and set the general standards and specifications of the system within which you operate. It is that same greater society which is responsible for the turmoil, the problems of race and discrimination, the imposed solutions such as busing, three-month summer vacations, and a variety of other limitations, strictures or frictions which both create the system within which education operates and interfere with its operating effectively, even within that system.

4. This unhappy state of affairs is not because the professionals in the education industry are less able or more venal than the rest of us. On the contrary, I suspect that the average professional in education works as hard, is at least as well trained, and if anything, more dedicated, than those of us who operate in the areas where productivity has been improving.

But, nevertheless, there is a striking difference between the educational system and private enterprise. The difference is in the different cultures of which we are each a part. The kinds of products and services we produce and sell in industry lend themselves to measurement, to pricing; and the system requires that we improve productivity or die. As a consequence, every product or service decision involves a dichotomy; the nature, the quality, the specifications of the product or service itself, and always its cost. When the market decides what combination of quality or product or service and cost it prefers, as often as not the decision is in favor of a little less product or service for quite a lot less cost. On the other hand, all of us also come from or still are a part of a school culture that equates a reduced adult-to-student ratio in the school system as the primary route to improved education. Indeed, within the present system, it is difficult to conclude otherwise.

Included in the Dallas Independent School District Operations Goals for 1972–73 are the statements shown in Figure 6.

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2.1 PROVIDE SUFFICIENT PARA-PROFESSIONALS TO ASSIST INSTRUCTIONAL PERSONNEL IN INDIVIDUALIZING INSTRUCTION. (PROBABLY REDUCING THE EMPLOYED ADULT TO PUPIL RATIO TO 1 : 18 IN AREAS I, II AND III)

2.2 PROVIDE EMPLOYED ADULT TO PUPIL RATIO OF 1 : 15 IN AREA IV

Source: Operations Goals, 1972-73, Dallas Independent School District

Figure 6

Since the ratio for the district for 1971–72 was 19.5, it is clear that the trend must be inevitably toward increasing costs, an increase undoubtedly contemplated in order to improve the quality of instruction. I do not believe, however, that this possibly can be the long-range solution unless the decrease in adult-student ratio is accompanied by a decrease in the total hours per student per year. There can be no escape from the constantly escalating costs, if the only solution is the expenditure of more and more man-hours of adult instructional and administrative time per student hour.

In spite of these criticisms, I applaud the existence of these Operation Goals and the thoughtful consideration of problems and opportunities they present. Indeed, it is exactly the kind of clear statement of goals that is a necessary prelude to approaches that will generate an increasing productivity. But somehow the goals have to change to find ways that maintain the quality of education with fewer adult hours per student hour.

Clearly, this cannot be a short-term solution, and under present circumstances there is nothing wrong with the 1972–1973 goals of the Dallas Independent School District as expressed. But unless there are active and energetic experimental efforts which have exactly the opposite goal;

i.e., equally effective education with fewer adult hours, there is no way out of the trap in which all are caught. The concept of productivity is just as valid in education as it is in the production of goods or food. The problem of measurement is much more severe, but the fact is that we have standards in education now which relate to accomplishment, however imperfect they may be, and most of us professionally engaged in any kind of activity can judge subjectively whether we are accomplishing more or less or about the same as we were last year or the year before, and that subjective judgment can be the basis of improved standards of measurement. Improving productivity in education is a difficult task, but not an impossible one, provided that the total systematic culture within which it is conducted recognizes the absolute need for steadily increasing productivity per employee engaged, if the goals of education itself are not to be aborted, and if those who spend their lives in the profession are to continue to be able to look forward to gradual improvement in their own standards of living and to deserve that improvement.

Most of the discussion thus far has been discouraging. Indeed, Dr. Bowen, in the remainder of the paper previously referenced, substantially concludes that educational costs will go on increasing relative to the rest of society, simply because productivity can't be improved at an adequate rate.

Frankly, I cannot agree with that conclusion. It is inconceivable to me that if we really want to, if we apply the multitude of talents we possess as a society, if you apply the enormous skills all of you possess who make up the profession of education, we cannot get 2% to 5% more work done each year than we did the year before. That is all it takes: 3% more productivity per person per year would keep up with the rest of society in general; 5% more productivity per person per year would generate a lead over the remainder of society and produce some surplus funds which, in turn, could be used to improve the quality of education itself without increasing real costs.

Further, as difficult as the challenge may be, there are also signs that the times are propitious for a change.

For one, we aren't going to feel the tremendous pressures engendered by an ever-increasing volume of students in most of our school systems (Figure 7).

The Office of Health, Education and Welfare forecasts that there will be 34.2 million students in elementary

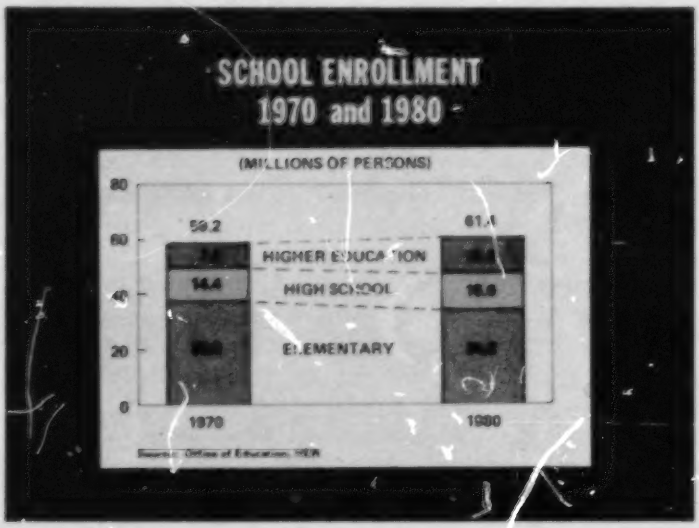

Figure 7

school in 1980, down from 36.9 million in 1970, a decrease of about 7%. Further, high school enrollment will remain relatively level over the decade. Only in the area of higher education will there be any significant increase, but even though the increase in students participating in higher education is forecast to grow by 55% (from 7.9 million in 1970 to 12.2 million in 1980), that still is nothing like the relative increase we had to face from 1960 to 1970, when there was more than a doubling of students in higher education.*

*Revised figures for 1980 School Enrollment, as reported in HEW's 1972 edition of *Projections of Educational Statistics to 1981–82*, indicate that the decrease in elementary school students will be 8% rather than 7% and the increase in higher education students will be 50% rather than

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Thus, we can cease the mad scramble to provide facilities and train people to keep up just barely with the growth and demand, and now we can divert time and effort to improve both quality and productivity.

Further, there are new tools available around which new systems of education can be built, and I stress *new systems* of education. Most attempts to use television or computers simply have grafted them on the old system and with little or no consciousness of cost and productivity. As a consequence, while there are any number of experiments which suggest that enormous gains can be made with these new tools, the actual impact on the educational structure to date is insignificant. Dr. Alvin Eurich in his book, *Reforming American Education*,[5] cites numerous examples of this kind of experience and points out opportunities for true reform.

For example, the MIT Sloan School of Management reported in January 1970 that using a system of computer-assisted programmed learning, "A body of material which usually takes a Sloan student an average of 18 hours to master was absorbed by the 30 in an average of one. One student was able to do it in exactly 36 minutes. As a result, the system—the Associated Learning Project, or ALP—will soon become the standard teaching device for 150 Sloan master's students in at least one course."[6]

Alpert and Bitzer of the University of Illinois, in a recent article in *Science* magazine, describe a computer-based education system developed from the first with the concept of both educational quality and economics in mind. They state:

> "A single Plato IV (an acronym for the computer-based educational system described) system operating 10 hours a day could provide approximately 10 million student-contact hours annually at a cost of about $3 to $4 million (with a total capital investment of approximately $12 million). This is equivalent to the total annual number of hours of instruction at a 4-year under-graduate institution with 24,000

students! Such an institution would typically have direct instructional expenses of well over $20 million annually and, in a university setting, a total budget several times greater. This comparison is obviously not meant to suggest that Plato could be substituted for such an institution. Rather, it is intended to indicate that a single Plato IV system could augment by 20 percent the instructional capacity of five such institutions on an annual budget of less than $1 million each."[7]

But even more important than these kinds of new tools, we need to ask ourselves if the kind of education we are providing now is right for all of the more than 14 million teenagers who are presently in high school.

According to the U.S. Office of Education, well over 50% of this year's high school graduates will enter college; in another 10 years, the figure probably will be 70%. Now we have eight million in colleges and universities; assuming present trends, in another 10 years we'll have 12 million. Is the only route to a college-level education to continue to be cooping up 12 million of our young people in the classrooms and relatively artificial atmosphere of school for so much of their lives? Mightn't it be better if, beginning at 15 or 16, those who wished could go to work for four to six hours a day and attend classes via television in classrooms at their work alone or with small groups of fellow workers for two hours or more a day? It isn't necessarily true that the number of hours it would take to conclude, first, high school and then college would be lengthened proportionately.

We all know that when learning is related to an end in which we are vitally interested or the necessary step in getting to do what we want to do, we learn at a much higher rate than when it is just a packaged something we need to know as a step toward a diploma or degree. I remember vividly just a few years ago learning by correspondence celestial navigation in a total of 25 or 30 hours spread over about six weeks and doing most of the

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studying and problem working while riding on airplanes, supplemented by a few hours at night before going to bed. I learned celestial navigation because I wanted to race a small boat across the Atlantic, and I worked my first night underway on the deck of my sloop after leaving Newport. Obviously, celestial navigation is not all that difficult, but I learned it much more quickly than subject matter of equivalent difficulty in my college years. Similarly, as a youngster in high school, building shortwave receivers and transmitters and getting my amateur radio operator's license, I learned a lot of electronics relatively much more readily than I did later in formal classes. Couldn't the combination of work and study be more effective or at least just as effective as stereotyped classroom teaching for millions of young men and women?

As many of you already know, in the North Texas region we have a closed circuit TV network with talk-back capabilities coupling nine universities and colleges and 46 classrooms in seven industrial organizations in a complex of nine locations around Dallas, Fort Worth and Sherman, Texas. The Tager TV network opened in September 1967 and presently is in its fifth year of operation. This spring a total of 70 graduate and undergraduate-level courses in business, engineering, science, and mathematics are being offered to a course enrollment of approximately two thousand. At Texas Instruments alone, we have 243 enrolled in programs, most working toward master's degrees. This is out of a total professional TI population in the Dallas area of over 4,500 of whom about 1,200 already have master's or doctorates. The program is already an overwhelming success; yet, we have not designed an educational system based on TV. We really just have augmented the present educational system geographically. Although there is some influence on the graduate-level subject matter by the individual organizations, in general, the schools are establishing the curricula and the industrial organizations are furnishing the classrooms, the students, and most of the funds.

Further, for all my emphasis in the earlier part of this discussion on the necessity for considering cost, and although costs of courses were considered in establishing the network, it was not designed with specific costs per student-hour goals in mind. Actually, the cost per student-instructional-hour is about comparable with normal university costs for the same kind of course. However, the convenience of the classroom locations and the scheduling of classes throughout the working day and evening ensure that many more professional people in the participating companies go on to postgraduate degrees and that the cost to the companies in lost working hours is markedly reduced.

The opportunities for really significant improvement in course applicability and quality are enormous, and the potential for producing this kind of improved educational opportunity at a striking decrease in cost is extraordinary. The system as presently constituted never has been designed or operated to achieve the really low cost per student-instructional-hour of which it is capable. Thus, because we really just have augmented the present system rather than designed a new system of education using these new tools and concepts, we still are not producing anything like the results that are potential. I am convinced that the development of a true television-based educational system for the kind of education that the people at such companies as Texas Instruments both desire and need all the way from high school through the Ph.D. and beyond into continued adult education can produce both a quality of education and productivity per educator far above that accepted as the norm in the high school or university, and further, that the system can be self-supporting.

It seems to me that the principal problems in our educational system are related to a misguided effort to use what was fundamentally an elitist system of higher education for carrying everyone through high school and a majority of those who graduate from high school on into college. This, I think, is a fundamental error. As a consequence, the

system is not well designed to satisfy the needs of most attending. A majority of the students finishing high school and going on into college, whatever their point of termination, is not really well prepared for a career. Indeed, many of these young men and women would have been better prepared had they simply gone to work somewhere in their late teens. The process has proceeded to the point where, whether appropriate or not, at least two years in college and often a college degree are the required ticket of admission to career opportunities of any consequence.

Should we abandon our attempts to educate all of our young people to the maximum of their ability? No, but we do need to change radically the methods we are using.

I am well aware that many, if not most, of you feel the same way; indeed, the Dallas Independent School District has been moving toward augmented career education at a rapid pace with the Skyline Career Development Center as one tangible accomplishment.

But I suggest that even the DISD's enlightened approach is not enough and that we need a radical revision in the institutional approaches we use to provide broader education to massive groups of people. I believe that our limited experience in Dallas, substituting TV in plants and offices for classrooms in universities, suggests that, for most students, required in-school classroom attendance could terminate after the 10th year. Thereafter, the broader education requirement for these students would be fulfilled in close connection with their jobs and at their places of work through highly flexible programs, using TV cassettes as well as TV classrooms, operated as adjuncts to live classrooms and as completely open-ended as possible so that one could continue working through any requisite number of years to attain various diploma levels from high school up. The course content quite properly should be set to augment the career being pursued and with the collaboration of the organization at which the individual is working, but the diplomas still would be granted by the

appropriate degree-granting institutions, such as the Dallas Independent School District for the high-school diploma.

Since the individuals concerned would be working in institutions, both business and non-business, and since anyone who wanted to do so could proceed as far, diploma-wise, as his competence and desire led him, it would remove a large part of the status-based social compulsion to complete, first, high school and then college in order to "belong," to be "eligible" for a suitable career. Actually, most vocational courses appropriate to the work done probably could be given more effectively and in a more applicable and timely fashion this way than the present system allows. This is at least as true for college-level vocational training, such as cost accounting or tax law, as it is for study we customarily think of as being at the trade school level, such as machine shopwork or office procedures.

One thing that definitely bothers me, for example, is that, even in industry, the road to anywhere near the top from the shop is becoming more and more difficult to traverse. The present mechanisms ensure that such a large percentage of those likely to succeed in management will have gone to college that, in general, enough college graduates will be put in the very lowest kind of supervisory positions to acquire experience, and some of them will proceed from there to the top. If the kind of open-ended educational process described could be established, then presumably a fairly sizable number with adequate ability would start in shop jobs while comparatively young, acquire their college educations or equivalents along the way via a combination of experience and the organized but nonresidential kind of programs suggested, and, once again, there truly could be people who progress from the shop to the top—and be much better prepared in addition.

On the basis of our training experience at Texas Instruments, there simply is no doubt that a carefully prepared instructional program on TV cassettes, plus the

requisite supplementary written materials for reference and testing, plus occasional tutorial help, is superior to conventional classroom teaching. It does have to be well done, and the student must want to learn; but those are requisites for any successful program of education.

A completely new system of career education, designed and supervised both by professionals in education and by those who employ the students and graduates of the new educational system, based on a combination of such carefully prepared TV cassette programs, plus TV classrooms operated in conjunction with live classrooms, would allow good teachers to reach many more students than they now do and break the present self-defeating emphasis on decreasing teacher-student ratios.

Indeed, as we all know, adequate preparation for a career in today's complex society is a process that needs to continue throughout one's working life. There is no conceivable way that packing all formal education into one's early life, terminating it with a diploma, whatever the level, in the Teens or early Twenties, and then going to work, possibly can be the best way of career preparation and development. Surely, the kind of new educational system described, in which many fellow workers of varying age and experience are continuing their formal education in such a visible, convenient, part-of-the-working-environment way, would induce a similar interest in a larger proportion of all of us who work. A properly structured curriculum would ensure that, in addition to career-oriented studies, a suitable proportion of cultural and social courses would be available as well. Surely, this kind of educational system not only would enhance the productivity of the educational system itself but that of the entire society, in addition to enriching the individual.

The Federal Government at the present time is supporting financially a wide variety of experimental programs. In Dallas we already have the beginnings of a TV network, top-notch approaches to career-oriented education

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in the Dallas schools through a business-education partnership, an aggressive junior college program, and a number of good colleges and universities. Most of them already are cooperating in the graduate-level educational programs conducted over the TAGER TV network.

Wouldn't it be worthwhile to take advantage of these very strengths here in Dallas to propose to the Federal Office of Education or to the National Science Foundation an experimental career education program, concluding most formal classroom attendance after the 10th grade and working out an open-ended cooperative program with industry, banks, retail stores, hospitals, and a variety of other non-business institutions, which would allow students thereafter to continue in an organized, but highly flexible and open-ended program, first, toward a high school diploma and then toward the bachelor's degree and post-graduate levels for those who desire?

Obviously, there are problems. State laws now make it difficult to employ anyone under 18 years of age. It would be a mistake for wage rates to be too high, because if they are, the student will be called upon to produce too much for his age and experience. But if we can make something like this work, we will be adding producing workers to the system years earlier than otherwise, instead of requiring that they be carried as overhead, coupling the training they receive to the work they are doing and reintroducing young men and women into real life work and living situations instead of isolating them in classrooms.

Some will fear that adding these young people to the work force earlier will magnify the unemployment problem. Given the necessary time to evolve the system, I have no concerns at all on this score. In fact, not all, but the overwhelming majority, of unemployed are either unskilled or in the very same age groups that our present education-work interface almost ensures will produce the kind of difficulties we experience in putting these same young people to work. The truth is that the needs of this society

are such that we can use the efforts of all who want to work and, given time, the frictions and imperfections will be corrected sufficiently to absorb in useful work the additional hours this kind of educational system would make available.

Even though the eventual costs per student-instructional-hour hopefully would be appreciably lower, there still would be complexities in how to divide the payment for those costs among the public, the organization for whom the individual is working, and the student himself. Very probably, during the early years of education involved, at least through high school and perhaps through the first two years of college-level work, the principal burden should be, just as it is now, borne by the general public through taxation. As the level of education rises, the percentage of the burden borne by the institution for which the individual is working and by the individual himself should increase.

In our present educational TV network, for example, TI has furnished the classrooms and our own part of the network completely at our own cost. The institution involved collects its usual fee for an hour of instruction from the student, and we repay 90% of these tuition costs to the individual for all courses completed with passing grades. In addition, we have made supplementary contributions to the educational institutions involved to compensate in part for the difference in their costs and tuition charges. Some of the class time falls during our normal working hours, and so long as the student's participation has been approved, he is paid for those hours. Of course, all present students are participating at the post-graduate level, and the existence of the program both helps us attract good professionals to our staff and improves their competence after they join us. I use this merely to illustrate that where there is an advantage to the employing organization, it usually will be willing to pay for its fair portion of the educational costs. I am confident that,

whatever the complexities, so long as the system is designed to predetermined student-instructional-hour costs and is based on an adequate and improving level of productivity per instructional or overhead person involved, the end result will be a lower cost per student-instructional-hour and a superior education, and we will have less difficulty financing it than we do our present system.

In a way, this would be doing what my friend at the dinner wanted to do when she suggested that our educational problems would be solved to a great extent if our young people could go back on the farms to work and learn, but it would be an urban solution to education for an urban society.

A consortium of involved institutions would be required, but leadership from the Dallas Independent School District is perhaps the prime element. I believe that a carefully constructed proposal of this kind led by the DISD would receive support from the community itself and excite the kind of interest at the Federal level that would ensure the necessary initial additional funding. The problems of the times demand bold approaches. What about it, Dr. Estes?

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R&D AND PRODUCTIVITY IN EDUCATION

Address by Patrick E. Haggerty
Chairman, Texas Instruments Incorporated

for the
American Educational Research Association
April 18, 1974

Most of us tend to associate the impact of higher productivities per person with the ability of the consumer to purchase more goods for relatively less money while, at the same time, the worker producing the goods truly can earn more. These are important consequences, but of at least equal significance has been the freeing of resources previously required for the production of food and other material goods so that they might be applied to improving health care or education or other desired services.

As recently as 200 years ago, 90% or more of any community had to be engaged in producing food. This left only a handful of men and women to be governors, craftsmen, merchants, scholars, artists, teachers, doctors.

Here in the United States in 1890 we still had an estimated 9.4 million people in agriculture to produce the food and the other raw agricultural products needed by a population of 63 million. Yet, in 1972, only 3.3 million workers were required to produce agricultural products for a population of 209 million. Had we been producing in 1972 as we were in 1890, it would have taken 41.6 million workers to produce the quantity of agricultural products consumed and exported in 1972. Thus, more than 38 million workers were released to man our factories and produce our industrial goods, but especially to move into the service areas, including health, government, and education (Figure 1).

In 1890, we had only about 500,000 workers in education, so there were 19 times as many workers in agriculture

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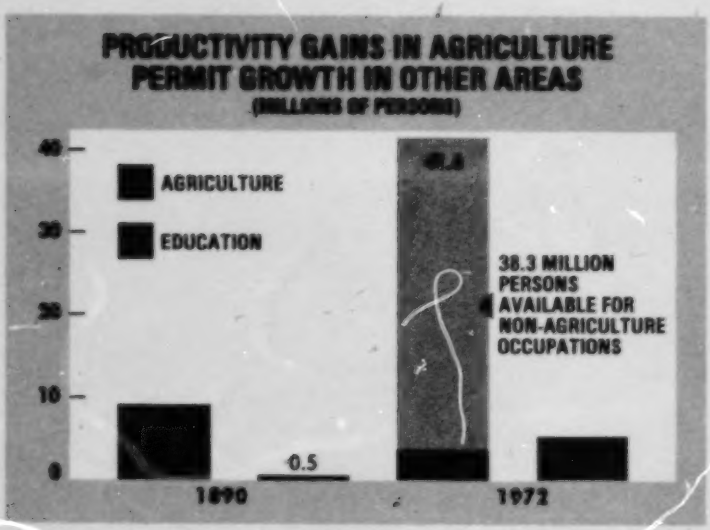

Figure 1[1a,b]

as in education. Since we had 5.1 million adults in education in 1972,* in a very real sense, more than 4.5 million of the workers released because of the increasing productivity in agriculture were released to go into education, and in 1972 there were more than 1.5 times as many workers in education as there were in all of agriculture.

As contrasted with the gains in agriculture and industry, there is every reason to believe that, in the overall, productivity per person in education has decreased.

Our expenditures per student have gone in constant 1971–72 dollars from $481 per student in 1951–52 to $1421 in 1971–72. Therefore, in 1971–72 we spent nearly three times more per student in constant dollars than we did 20 years earlier (Figure 2).

All of us know, of course, that it is extraordinarily difficult to measure productivity in education with any accuracy and that this comparison of cost changes per student with time is an oversimplification. But I don't

*Includes all full-time equivalent personnel employed in academic education. The total employed in all education, both academic and non-academic, was 5.7 million.[1c]

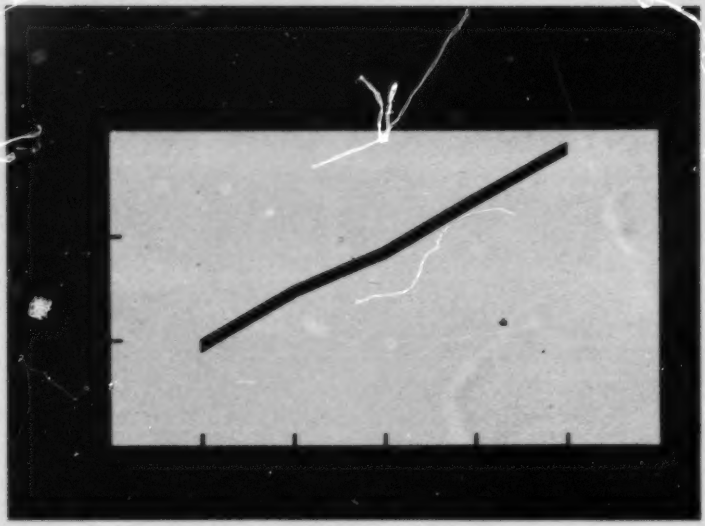

Figure 2[2]

think there is anyone in the field who believes that productivity per adult engaged in education is anything like three times what it was in the early Fifties. Since that is what has happened to costs per student, the necessary conclusion follows that productivity per person in education has decreased.

In 1890, or probably even 30 or 40 years after that, when the total number of adults engaged in education was relatively small, the fact that productivity in education was not increasing was not terribly important. In a very real sense, the productivity gains in agriculture and industry were so large, and the number of workers in them so many by comparison to the few in education, that the men and women in industry and agriculture literally could carry on their backs the added costs to society occasioned by the failure to increase productivity in education. In terms of the total resources of society, the extra burden simply wasn't significant. That is no longer true. The nearly

$86 billion we spent in support of regular educational institutions in school year 1971–72 represents nearly 8% of our Gross National Product, and the 5.1 million adults in education were 6% of our total working population. It may be unpalatable to those in education, but they have been dependent for any real gains in their own pay upon the increasing productivity of the other sectors of the economy, and only to the extent that education has contributed to that increasing productivity have those who make their living in education earned their increased compensation.

Nor does this tell the whole story. In 1951, the United States had a total population of 156 million. There were over 1,800,000 adults in instructional administration and approaching 37 million students enrolled in regular public and non-public institutions from kindergarten through post-graduate in that school year. This means that in that school year, 1951–52, just under 25% of our total population had made education their major time commitment. By 1972, with more than 5 million adults and 60 million students, over 31% of our total population were so committed. Not only are its high purposes still of overriding importance to both our cultural and material development, but education has become so pervasive—indeed, the major commitment of nearly a third of our people—that it is imperative we learn how to improve the overall productivity of our total educational establishment.

This observation is hardly very novel. It has been made by many, both inside and outside of education, over the past decade. Most who doubt that it will be possible to improve the productivity per person in education at any kind of adequate rate usually do so because of their conviction that there is no substitute in education for a low student/adult ratio, and hence no way out of the ever-increasing costs with educational wages inevitably pressed up by the increases in the rest of society.

Similarly, many who press for improving productivity per person build their hopes for such achievement on the

potential availability of such new tools as television and computer-aided instruction, and they urge the organizational and institutional changes they see as necessary before such new tools can become effective.

I am personally certain that those who doubt our ability to improve productivity per person in education significantly are wrong, but I am about equally convinced that those who are confident that all that is required is widespread adoption of these new tools are also wrong.

Fundamentally, I believe the problem is a cultural one. The attitudes requisite to constantly improving productivity per person must be built into the culture in which the individuals work. Those who are responsible must approach their responsibilities in a way that takes for granted that more resources, either for their work or as personal financial rewards for doing it, can come only because more is accomplished per person this year than last year and that next year still more per person must be done.

Every long-lasting institution evolves a culture of its own, and Texas Instruments, the organization to which I have devoted most of my professional life, is no exception. Our culture is determined by our policies, procedures, and practices as they are formally stated and installed as systems and as they actually are perceived and executed by the individuals who make up Texas Instruments. These policies, procedures, and practices—and the culture they produce—are aimed at creating, making, and marketing products and services to satisfy the needs of our customers around the world and are keyed to the incentive provided by the profits we make.

The system forces us to recognize increasing costs, either by increasing prices or improving productivity per person, or both. Competition on a worldwide basis severely limits our ability to increase prices. In fact, in sectors of our business totaling about half our annual volume, we have had average price decreases over the past two decades of about 15% per year. We have been forced to learn how to use science and technology, capital and management, to

improve our productivities per person and reduce our overall costs.

The relatively automatic operation of the market economy creates a culture common to all private enterprise, a culture that is dependent upon and oriented toward the need to provide products and services for customers at a profit. It is a culture in the full sense of the word, one that automatically biases the entire sector toward high and increasing productivities per person, and it does not exist in the not-for-profit sector.

I have not used this illustration as a pitch for our mixed-market economy or to suggest that our educational system should be in the profit sector, although I do think a very considerable part of it could be and would operate in an improved fashion if it were. What I am trying to convey is that, just as the market and its profit system automatically generate a culture biased toward constantly increasing productivities per person, so also some equally effective change in educational culture will have to be generated if it, too, is to become biased toward constantly increasing productivities per person. No simple addition of tools and technology will accomplish this shift. Those who believe so are being fooled by the apparent ease with which tools and technology accomplish improvements in productivity in the private, profit-making sector, where the cultural bias of the system seeks them out, and there is a constant and pervasive pressure toward increasing productivities per person.

Within education, on the other hand, the culture imposes a bias in exactly the opposite direction. To oversimplify only a little, our entire educational system is a complex of teachers, each surrounded by a small circle—and the smaller the better—of students to whom the teacher is imparting his or her knowledge of the specific subject matter of the

course, plus a considerable addition of general wisdom. The administrative structure is tolerated as a necessary nuisance to support the complex of the small teacher-centered circles. Thus, even though teachers have long recognized that every student is an individual, the overall culture and the system it engenders are teacher-centered.

The cultural bias in education toward ever-decreasing student/adult ratios has been just as effective in its way as has the opposite bias toward ever-increasing productivities per person in the market sector. Note the upper curve showing the ratio from kindergarten through eighth grade, with the ratio decreasing from 30.7 in 1951–52 to 21.7 in 1961–62, down to 18.2 in 1971–72. Further, HEW projects a still lower ratio of 16.2 in 1981–82.

Similarly, for the high school years, the ratio has decreased from 14.9 in 1951–52 to 10.5 in 1961–62, 9.7 in 1971–72, and is projected to go on down to 9.4 in 1981–82 (Figure 3).

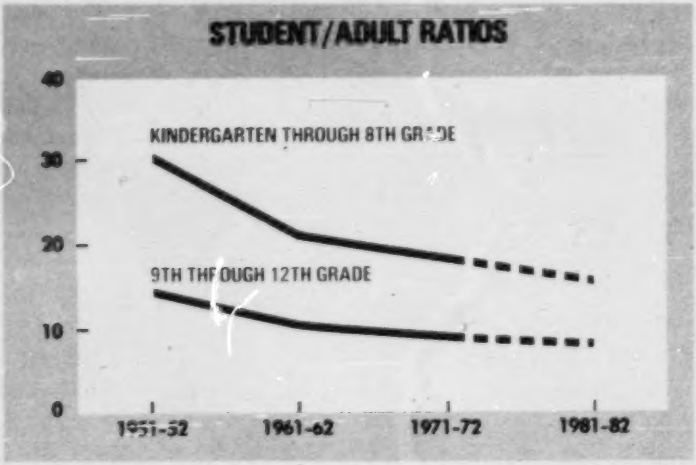

Figure 3[3]

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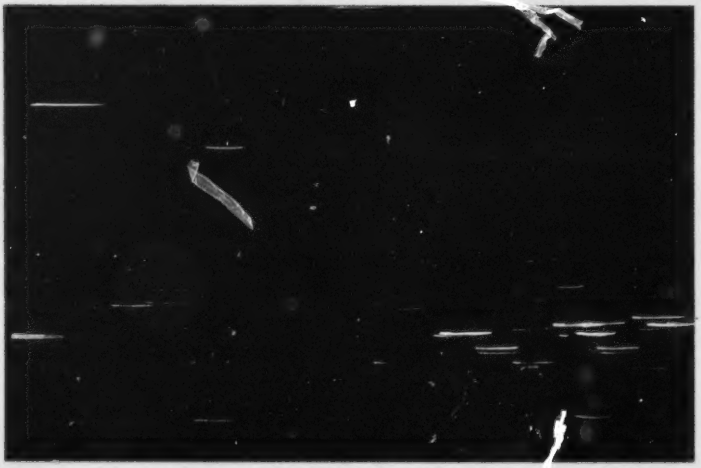

Figure 4

As another very specific illustration, Figure 4 shows a statement from the Operations Goals for 1972–73 of the Dallas Independent School District.

Since the ratio of pupils to adults for the year 1971–72 was 19.5, the trend is clearly toward increasing costs and decreasing productivity per person. The superintendent of the Dallas Independent School District is Dr. Nolan Estes, a man for whom I have enormous respect. He has to be one of the most competent school superintendents in the entire nation, dedicated, innovative, and energetic. I have great confidence in his judgment, and I have no doubt whatsoever that that goal is there because Dr. Estes and the administrators and the teachers who shared with him the responsibility for setting it believe firmly that a reduced student/adult ratio is essential to improve the effectiveness of education for the student. Nor do I doubt that they are right, *so long as we operate within a cultural system that is fundamentally teacher-centered.*

Thus, the teacher-centered culture is very pervasive in its bias toward decreasing student/adult ratios, and so long as the primary mechanism for attaining educational objectives

is seen as ever lower ratios, the culture must retain the bias, and additions of tools and technology are likely to be peripheral at best in their impact. If, indeed, this teacher-centering is the only effective way to achieve educational goals, then it is going to be extraordinarily difficult to attain the increased productivities per person which seem essential if the total resources required are not to become astronomical.

Some of our most able and dedicated educators truly believe that education is caught on the horns of a dilemma with the only route to fulfillment of adequate educational goals blocked by the need for constantly increasing resources and society's ability and willingness to provide them. I do not believe this pessimism is justified, and I think one can see a different culture developing in education which need not include this bias toward ever-decreasing student/adult ratios and which by its very nature is susceptible to adding the concepts required if constantly increasing productivities are to be attained.

This different culture, which I would describe as student-centered instead of teacher-centered, is not something new and foreign to the field of education. It goes back at least to 1919 and the Winnetka, Illinois, plan with self-pacing and mastery demonstration as principles of instruction. Self-pacing and required demonstration of mastery of subject matter before proceeding to the next unit of study are being used at an increasing rate in teaching college-level science. Kulik, Kulik, and Carmichael discuss a number of such programs and their apparent effectiveness in the February 1, 1974, issue of *Science*.[4]

At the elementary school level, the University of Pittsburgh's Learning Research and Development Center believes that one of its significant research results is what it calls Individually Prescribed Instruction. IPI stresses as its major objective the ability of each student to work at his own rate through units of study in a learning sequence and the development in each student of a demonstrable degree of mastery flowing from self-paced and self-directed effort.

Research for Better Schools, Inc., in Philadelphia has collaborated with the Learning Research and Development Center to involve nearly 90,000 elementary school children in one or more of these IPI programs.

Another effort at the elementary school level is Individually-Guided Education (IGE) in a model developed by the Wisconsin Research and Development Center for Cognitive Learning with the Institute for the Development of Educational Activities (IDEA) also contributing. In this current school year, there are about 1700 elementary schools in 37 states using this IGE model. Since there were only seven such schools, all in Wisconsin, as recently as 1967–68, this cultural shift to student-centering is clearly growing at a high rate.

These illustrations are just some of the efforts around the nation to shift from teacher-centering to student-centering.

One of the most stimulating and challenging discussions of individually paced, mastery-oriented teaching is Fred Keller's 1967 presidential address to the American Psychological Association, that he called "Good-bye, Teacher." In his address, Dr. Keller summarized the following features of this teaching method he felt distinguished it most clearly from conventional teaching procedures:

"1. The go-at-your-own pace feature, which permits a student to move through the course at a speed commensurate with his ability and other demands upon his time;

"2. The unit-perfection requirement for advance, which lets the student go ahead to new material only after demonstrating mastery of that which preceded;

"3. The use of lectures and demonstrations as vehicles of motivation, rather than sources of critical information;

"4. The related stress upon the written word in teacher-student communication; and finally;

"5. The use of proctors, which permits repeated testing, immediate scoring, almost unavoidable tutoring, and

a marked enhancement of the personal-social aspect of the educational process."[5]

Earlier, I identified this new educational culture as student-centered. In his address, Dr. Keller describes the difference between teacher-centering and student-centering:

"In systems like these, and in the one I have centered on, the work of a teacher is at variance with that which has predominated in our time. His public appearances as classroom entertainer, expositor, critic, and debater, no longer seem important. His principal job, as Frank Finger (1962) once defined it, is truly 'the facilitation of learning in others.' He becomes an educational engineer, a contingency manager, with the responsibility of serving the great majority, rather than the small minority, of young men and women who come to him for schooling in the area of his competence."[6]

I would like to emphasize that, while the shift from teacher-centering to student-centering is indeed a complete cultural shift, it does not automatically provide the emphasis on increasing productivity per adult that seems a necessity.

Indeed, although there does seem to be considerable evidence that results with students are superior, many of the IPI and IGE programs are at least as prodigal in the use of adult manpower as any teacher-centered program. On the other hand, in a student-centered culture, adding the requirement for constantly increasing productivity per adult does not generate any conflict in fundamental purpose as it inevitably does within the teacher-centered culture.

The Wisconsin R&D Center's multi-unit school model illustrates what I mean. There, the traditional, self-contained classrooms are replaced with larger, non-graded units. In each unit a unit teacher, two or three staff teachers, a first-year teacher, a teacher aide, an instructional secretary, and an intern work with 100 to 150 students in a three to four-year age span. Unit leaders and building principal make up an instructional improvement committee

and cooperatively define the school's educational goals. At the district level, a system-wide policy committee—which includes central office administrators and consultants, principals, and representative unit leaders and teachers—develops policy guidelines and coordinates the use of human and physical resources. Even though this Individually-Guided Education model does not include productivity goals as a part of its structure, and although early costs with innovative approaches are unfortunately usually high, a study of 39 of these multi-unit elementary schools in eight states showed little or no increase in costs per student, including expenditures involved for instructional materials and equipment.[7]

In a multi-unit, student-centered school system, productivity goals can and should be set for the whole system rather than just for individual grades or for individual schools. Manpower and other resources of the entire system can be pooled to achieve the overall student/adult ratios necessary to assure increasing productivities. Student/adult ratios can vary widely as may be necessary or demanded by the subject matter or the students to achieve the learning objectives sought so long as the overall goals are met. The entire school system can be so oriented as to develop in the individual student a growing ability from his earliest years in school to self-initiate, self-pace, and self-rely. If this calls for even lower student/adult ratios in the earlier years than we are using now, all well and good, provided this increase is counterbalanced by higher ratios in the later years. If some students require more help and lower student/adult ratios, this need not affect overall productivity per person so long as these lower ratios are balanced by higher ratios among students requiring less adult help.

Tools and technology, instead of being simply grafted on a teacher-centered system not well suited to use them, can be adapted or designed to meet the needs of the learning and productivity goals established. TV classrooms at scattered locations conducted in conjunction with live classrooms, computer-aided instruction, audio and TV

cassettes—and new combinations, new tools, and new technologies not yet thought of—all can be applied as necessary to meet the needs of the individual and the productivity goals of the school system, but so can books and correspondence courses designed to meet the learning goals and the students' needs adequately. We already know that many of the new tools and technologies, such as computer-aided instruction and audio and television cassettes, lend themselves especially well to individualized, self-paced instruction.

An educational system with a student-centered culture can be far less structured in its institutional responses than our present system. For example, with an entire school system organized on this basis, there would no longer be any need for the present school year and summer vacation pattern. Provided established learning and productivity objectives were achieved, students and adults alike could fit in vacation time much more flexibly throughout the year.

Obviously, I do not believe this shift to a student-centered educational culture can be considered properly implemented until it consistently includes productivity goals as well as educational goals. I certainly would hope that one of our R&D laboratories concentrating on student-centering, such as the Wisconsin Research and Development Center for Cognitive Learning, will expand its R&D efforts to include work on improving individual productivities so that these conceptions can be developed to the point where they become a built-in part of the entire approach.

Figure 5 illustrates the kind of productivity gains that would be really meaningful. Of course, the desired student/adult ratios must be attained school system by school system and as established to meet the needs of that particular system, but in my examples, I will work from the overall national ratios.

The actual student/adult ratios in 1971–72 were 18.2 for the elementary level, 9.7 for high school, and 6.1 for higher education. For decades, in manufacturing industry, average gains in productivity per person per year of about

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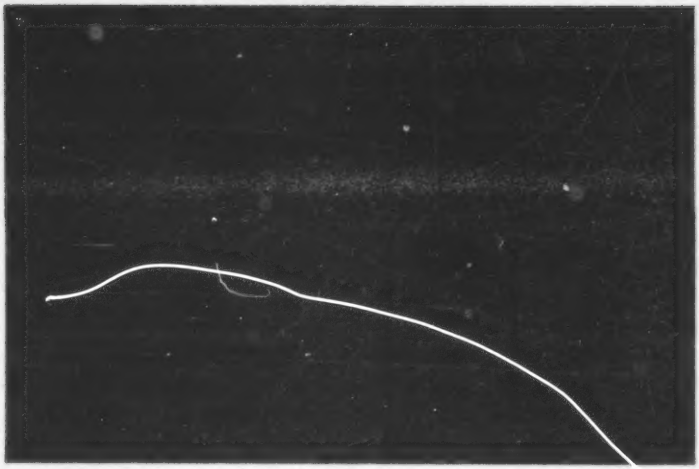

Figure 5[8]

3% have been attained. Agriculture has been running considerably higher than that, 5% or more per person per year. But certainly a 3% gain per person per year in productivity would represent a very significant accomplishment for education. If we could assume that over the 10 years following 1971–72 we could have taken steps to achieve that 3% gain in productivity per person per year, while still meeting our educational goals, the student/adult ratio in 1981–82 would be 24.5 for the elementary level, 13 for high school, and 8.2 in higher education.

These are not by any means impossible goals, as illustrated most graphically by comparing them with the ratios I presented earlier for kindergarten through eighth grade and for high school. The 24.5 ratio for the elementary schools in 1981–82, for example, is well below the 30.7 ratio that existed in 1951–52, and the productivity goal of 13 for high school is below the nearly 15 that prevailed there in 1951–52.

Yet, it is gains in productivity per person per year of this magnitude that we should be seeking, and the R&D being conducted on student-centered systems should be searching for approaches which will allow these kinds of productivity

goals to be established and attained along with the educational goals. (I should add that I am oversimplifying in talking about productivity exclusively in terms of student/adult ratios. Obviously, one must be concerned, as well, about the other costs involved, and if these improved student/adult ratios are attained by increasing facility, equipment, and supplies costs unduly, no overall reductions in costs will result.)

In beginning this discussion, I emphasized that I thought one of the most important consequences of improving productivity per person was the human resources made available to society. Now I know that to many, looking at it in the shorter perspective, it looks instead like putting people out of work. Yet, it should be clear from the agricultural example I gave earlier that, in fact, in an active, economically dynamic society such as ours, what really happens is that those resources are made available to do something else of more significance in the society.

Figure 6 shows what this kind of modest gain in productivity per year would make available in 10 years, assuming the total number of students in each of the three categories projected for 1981–82 by the Department of Health, Education and Welfare.

Figure 6*

There would be 543,000 fewer adults in elementary schools, 455,000 fewer in high school, and only 68,000 more in higher education, in spite of an increase in enrollment of more than 3.5 million. Thus, across education as a whole, more than 900,000 highly qualified men and women would be made available to society to take on other tasks.

Obviously, we are not going to have this kind of opportunity in 1981–82 because the overall cultural shift to student-centering is only beginning, and it will take many years to penetrate all of education. I wish we were going to have it, because I am convinced that when our whole educational culture is student-centered there are going to be two very important consequences:

1. The adult citizens it produces, accustomed from their elementary school years through higher education to self-initiated, self-paced education and its relative freedoms from the limitations of rigid schedules and fixed geographical locations, will have developed to a far greater extent than at present both the desire and ability to continue organized study and learning throughout their entire lives.
2. We will have in place in the United States a highly flexible educational system, with the flexibility increasing with level and freed in the most part from the rigidities of fixed class schedules and specific school locations. It will be perfectly feasible to mix work and education in almost any combination that meets the individual's needs both from a time and subject matter standpoint. Many students will begin mixing regular jobs and continuing study by their early high school years. Most will in college. The rate of change and increasing complexity of our society will require adaptation and continued learning from all of us, and the convenience and ready and broad availability of self-initiated and self-paced study will make it customary for most adults to continue this kind of formal education throughout their entire lives. Presumably, the principal impetus will be the demand

of their own career progressions, but wise development of the overall system will ensure that the opportunity for continued cultural development is equally available and sought after.

Present reproduction rates in the United States suggest that our population is likely to stabilize not too far from the 250-million level, perhaps in another 40 to 50 years. With this kind of student-centered learning system in place, I think the likelihood is very high that instead of 30% of our total population being involved in formal education, three-quarters of them will be. None of this will be possible until we find ways of freeing resources to allow it. We are going to need those 900,000 adults and the resources they represent, and that is why I wish we were going to face the problem and the opportunity that the higher student/adult ratios I projected as goals would generate.

There is in the nation, and specifically in our Congress, a great deal of justifiable concern at the apparent ineffectiveness of much of the research and development in education. Indeed, it does not take too much examination of the R&D efforts in education of this past decade or so to conclude that there has been much waste and that too much of the effort has been unproductive. That being the case, one of my principal preoccupations since becoming Chairman of the National Council on Educational Research on its initiation last July has been to ask those who have participated in educational R&D to give examples of demonstratedly successful consequences from R&D, including the evaluation data that justify the judgment that these are successful efforts.

Incidentally, I want to hasten to emphasize that the judgments I express are entirely my own; in no sense, am I speaking for the National Institute of Education or the National Council on Educational Research. To me, although some of the examples given do, indeed, represent good work with high potential for affecting education positively, in the overall the responses have been singularly unsatisfying and not very helpful in convincing the skeptic

that past research and development in education has been worthwhile or—even more important—that it justifies continued and enlarged financial support in the future. Even those most enthusiastic about the probable impact of IPI or IGE have, it seems to me, tended to emphasize the more immediate and narrowly based consequences of these efforts. Yet, I am convinced that the overall eventual impact of the research and development bringing about this shift in our educational culture from teacher-centering to student-centering is of overwhelming importance and that its consequences will be of exactly that far-reaching and constructive kind that one hopes for and which occasionally results from R&D. If so, then, these consequences alone are more than sufficient to justify many times over the total resources committed thus far to the entire educational research and development effort. It is true that, for the kind of revolutionary consequences I envision to develop: (1) a more coherent pattern of student-centering must evolve, extending from kindergarten completely through higher education; (2) productivity goals must be included normally and routinely along with the other important educational goals, and (3) we must succeed in developing the kind of lifelong education patterns I anticipate.

But, in turn, these are exactly the important effects that student-centering makes possible and are in themselves areas where fruitful additional research and development can and should be conducted. The researchers involved do have to develop a clearer and more coherent vision of what is sought, and the overall effort needs to be broadened and coordinated so that the total potential of the shift may be realized, but no one working in this field need be diffident as to the significance of his effort.

I suggest that not only is the research and development producing the student-centering of major significance to education, but it is one of the most important efforts in research and development in any field now being conducted. Further, I am convinced it will succeed.

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